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(71) Applicant: Sloan-Kettering Institute For Cancer
Research
1275 York Avenue
New York New York 10021(US)

(72) Inventor: Hammerling, Ulrich
430 East 63 Street
New York New York 10021(US)

(72) Inventor: Hoffman, Michael K.
132 Greene Street
New York New York 10012(US)

(74) Representative: Patentanwälte Schulze Horn und
Hoffmeister
Goldstrasse 36
D-4400 Münster(DE)

(52) Process for producing human monoclonal antibodies.

(37) A method for producing human monoclonal antibodies from human B-lymphocytes comprising the steps:

1. immunization of human B-lymphocytes;
2. transformation of HBL by a viral agent to generate immortalized cells;
3. selection of cells secreting specific antibodies and cloning of these cells; and
4. fusion of the cloned cells with suitable human or mouse myeloma cells to generate high-secreting hybridoma, and cloning of these hybridomas is disclosed.

The method may be used to produce human monoclonal antibodies which recognize HLA, A, B, C or DR antigens and also to produce human monoclonal antibodies recognizing cytomegalo-virus antigens. Human monoclonal antibodies deposited at the American Type Culture Collection with deposit numbers HB 8317 and CRL 8316 have been produced by this method.

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10 Process For Producing Human Monoclonal Antibodies

This invention concerns human monoclonal antibodies. A novel method for their production involving immortalization of human antibody-secreting cells prior to fusion and conversion to hybridoma cells is disclosed. Human
15 monoclonal antibodies recognizing human cell surface antigens and viruses associated with the herpes group are disclosed.

20

Summary

The present invention is concerned with a method for producing human monoclonal antibodies from human B-
25 lymphocytes which comprises the following:

1. immunization of human B-lymphocytes (HBL) in tissue culture,
- 30 2. transformation of HBL by a viral agent, preferably Epstein-Barr virus to generate immortalized cells;
3. selection of cells secreting specific antibodies and cloning of these cells; and
- 35 4. fusion of the cloned cells with suitable human or mouse myeloma cells to generate high-secreting

1 hybridomas, and cloning of these hybridomas.

5 The method may be used, for example, to prepare human monoclonal antibodies which recognize HLA, A, B, C or DR antigen by transforming PBL which have been immunized in vitro with the antigen or by transforming PBL from blood of multiparous women with high anti-HLA and/or DR antibody titers.

10 The method may also be used to produce human monoclonal antibodies recognizing cytomegalo virus antigens by transforming PBL from an individual exposed to cytomegalo virus with a viral agent, preferably Epstein-Barr virus to generate immortalized cells and fusing the
15 transformed cells with a second immortal cell line. Human monoclonal antibodies designated 312 A 91.4 and 311/25 have been produced by this method.

20 Background

25 Successful production of murine B-lymphocyte hybridomas made it possible to manufacture antibodies with restricted specificities in large quantities. However, attempts to produce human monoclonal antibodies with the methodologies established for the murine antibodies have failed.

30 Human monoclonal antibodies to human cell surface antigens, especially the major histocompatibility complex (MHC) have been sought. A number of mouse monoclonal antibodies (mAb) to HLA, A, B, C surface antigens and to DR antigens have been prepared (Brodsky, F. M., Parham, P., Barnstable, C. J., Crumpton, M. J., and Bodmer, W.
35 F. Immunol. Rev. 47:3 1979; Trucco, M., Garotta, J. W., Strocker, J. W., and Cepellini, R. Immunol. Rev. 47:219, 1979; Trucco, M., Stocker, J. W. and Cepellini, R.

1 Nature 273:666, 1978; Quaranta, V., Pellegrino, M. A.
and Ferrone S. In: Monoclonal antibodies and T cell
5 Hybridomas. Eds. G. J. Hammerling, U. Hammerling and J.
F. Kearney. Elsevier North Holland, Amsterdam, p. 84,
1981; Lampson, L. A. and Levy, R. J. Immunol. 125:293,
1980). These antibodies have been showed to react with
antigenic sites common to all MHC antigens, but except
10 in isolated instances do not react with polymorphic
determinants of the human MHC. General experience in
immunogenetics has taught the value of alloimmunizations
and the fine specificities of the resulting alloantibo-
dies. Accordingly, only alloantibodies are regarded as
suitable to chart the genetic and serological complexi-
ties of the human MHC, and hence ultimately provide the
15 reagents necessary for human tissue typing. It is to be
expected that relevant monoclonal antibodies will derive
sooner from alloimmune than from heteroimmune lympho-
cytes. Previous human monoclonal antibodies to human
cell surface antigens, notably to MHC antigens are not
20 known.

Human monoclonal antibodies associated with viruses of
the herpes group have also been sought. The herpes virus
group consists of a large number of viruses which are
25 either etiological agents or found associated with nume-
rous human illnesses. They include Herpes type 1 and
type 2, Cytomegalovirus, Varicella Zoster, Epstein-Barr
Virus, among others. Cytomegalovirus (CMV) is in itself
a complex group of viruses, the members of which can
30 cause many diseases in man. Serological classifications
of CMV in pertinent serotypes is incomplete at best.
Monoclonal antibodies would provide ideal reagents for
serotyping. Human monoclonal antibodies would also be
important adjuncts for the treatment of CMV infections,
35 as implied from the beneficial use of immune gamma
globulin in patients. To date, human monoclonal antibo-
dies with specificity to CMV have not been produced.

1 It is now clear that the biology of human B-lymphocytes
necessitates a total change of approach from that used
in the murine methodology in order to produce human
monoclonal antibodies.

5

Description

10 The present invention will be more fully understood from
the following description taken in conjunction with the
accompanying drawing wherein Figure 1 depicts the virus
transformation step of the method.

Human monoclonal antibodies obtained by the method
15 disclosed in the present invention bear the designated
deposit number and are deposited with Sloan-Kettering
Institute, 1275 York Avenue, New York, New York 10021.
Preferred cell lines of the present invention are also
deposited at the American Type Culture Collection,
20 Bethesda, Maryland and bear the following deposit
numbers:

	<u>SK Deposit Number</u>	<u>ATCC #</u>
	312 A 91.4	HB 8317
25	311/125	CRL 8316

Deposit is for the purpose of enabling disclosure only
and is not intended to limit the concept of the present
invention to the particular materials deposited.

30

The terminology "lymphocyte" and "cell" is used inter-
changeably in this application - as is usual in the art.

In accordance with the inventive method, a reliable
35 source of immunized human B-lymphocyte must be obtained.
Preferrably normal peripheral blood lymphocytes consti-
tute that source. Towards this goal a culture method has.

1 been developed (Hoffman, M. K. Proc. Nat'l. Acad. Sci.
USA 77, 1139, 1980; Lane, H. C. et al. J. Exp. Med. 154,
1043, 1981; Misiti, J. et al J. Exp. Med. 154, 1069,
1981; Morimoto, C. et al. J. Immunol. 127, 514, 1981)
5 that permits effective immunization of unsensitized
human PBM to sheep erythrocytes (SRBC) or antigens con-
jugated to SRBC (such as trinitrophenyl groups, TNP) and
immunization of presensitized human lymphocytes to other
antigens (tetanus toxoid, alloantigens). Specific B-lym-
10 phocytes obtained in this method can be readily trans-
formed according to the present invention with EB virus
and TNP specific as well as other antigen specific
transformed B cell lines have thus been obtained. For
convenience, the PBL, once obtained, may be cryopreser-
15 ved prior to immunization.

It is possible that antibody-secreting human B cells, as
terminally differentiated cells, have in their biologi-
cal life cycle a limited allowance of generation cycles.
20 It is conceivable such a block is a dominant feature
which might negatively influence the fusion cell part-
ner. The contention that human plasma cells have a
limited potential for proliferation is supported by the
low frequency of human plasmacytomas, the general diffi-
25 culty of adapting such plasmacytomas to cell culture,
the reported failure to clone immunoglobulin secreting
plasma cell type progeny of EBV transformed B cells (Fu,
S. M., et al J. Exp. Med. 148, 1570, 1978), and the
inability to maintain normal human B cells in the PFC in
30 culture. In fact, the situation may not be different in
principal from that of mouse plasmacytomas which are
infrequent in most mouse strains except the BALB/c
strain (Potter, M. Methods in Cancer Research. Ed. H.
Busch. Academic Press. Vol. 2, 1967, p. 105).

35

Based on this hypothesis the inventive method was de-
vised to circumvent the possibility of a biological

- 1 block using an adaptation of EBV transformation technique as a means of immortalizing and cloning human allo-antibody-forming cells to human lymphocyte surface antigens, specifically to HLA-A, B, C and DR antigens.
- 5 Clones of low-secreting cells may be then turned into high-secreting cells by fusion with standard murine plasmacytoma cells or human myeloma cells.

The inventive method for generating human monoclonal antibodies (mAb) comprises essentially the steps:

- 10 (1) human B lymphocytes are sensitized or immunized using a suitable antigen; immunization is preferably in vitro but sensitized PBL of high titer to a specific antigen may also be employed;
- 15 (2) the antibody producing cell lines are then immortalized by EB virus transformation;
- 20 (3) the transformed cells are fused with a second immortal cell lines, a mouse myeloma cell line, for example.

The transformed cell lines are then cloned -- that is, after culturing, one selects those cell colonies which have the desired characteristics --; and the cloned cell lines are grown to produce the desired antibodies. The method may comprise, in addition, the steps of cloning transformed cells, screening the cloned transformed cells for antibody secretion and selecting for fusion the efficient antibody secretors - that is, those which secrete the larger amounts of antibody under the cloning conditions.

35 The following examples are provided to illustrate the method of the present invention and the human monoclonal antibodies that have been obtained thereby. They are in

1 no way, however, intended to limit the scope of the
invention.

5 EXAMPLES

I. Human mAb to nominal antigens, sheep erythrocytes
(SRBC) and trinitrophenyl groups (TNP)

- 10 a) Isolation of human peripheral blood lymphocytes
(PBL): This procedure follows standard ficoll-
hypaque density gradient centrifugation. 50 milli-
liters of human blood are diluted with a twofold
15 volume of Earles balanced salt solution (EBSS),
layered on lymphoprep (Ryegard, Denmark) and cen-
trifuged at room temperature for 30 min. at 1800
RPM. The cells from the interface are isolated,
washed in EBSS and counted.
- 20 b) In vitro immunization of PBL with TNP-SRBC.
40 x 10⁶ Human PBL suspended 10 milliliters of in
Mishell Dutton medium (Mishell, R. I. and Dutton,
R. W. J. Exp. Med. 126:423) containing ₅ 5 % fetal
calf serum (FBS), antibiotics, 5 x 10⁵
25 2-mercaptoethanol (2-ME). Thirty microliters of a
50 % suspension of heat-killed staphylococcus
aureus, strain Cowan I, 300 microliters of B cell
differentiation factors (BDF) (Hoffmann, M. K.,
Proc. Nat'l. Acad. Sci. USA 77:1139, 1980), and 50
30 microliters of a 6 % TNP-SRBC suspension are added
to this cell suspension, and the mixture is then
distributed evenly into one 96-well Costar plate.
The cells are cultured for 18 hours in humidi-
fied CO₂ incubators, and 10 microliters of human
35 AB serum is added to each well. Culturing is con-
tinued for 4 days with intermittent feeding by 10
microliters of feeding cocktail (Mishell, et al.

1 Supra) every other day. The cells are then har-
vested, washed in EBSS and counted. Antibody for-
mation is assessed by the Jerne plaque assay
5 (Jerne, N. K. and Nordin, A. A. Science 140:405,
1963) using TNP-horse erythrocytes and SRBC.

c) Isolation of B cells and transformation by
Epstein-Barr virus (EBV)

10 Immunized PBL are adjusted to 4×10^6 cells per ml
in medium containing 5 % FBS. 10 milliliters of
the mixture is added to petridishes coated with
polyvalent affinity-purified rabbit anti-human Ig
antibody. The dishes are prepared by incubating 10
15 cm microbiological-grade plastic dishes with 10 ml
of the antibody at 10 micrograms/ml overnight in
the refrigerator, followed by blocking residual
sites by incubation with a 10 % solution FBS in
EBSS for 1 hr. at 37°C . B cells are allowed to
20 attach during 3 hrs. at 4°C . The plates are then
washed gently with EBSS twice to remove T cells.
10 ml of a virus solution containing high-titers
of EBV are added to the plate which is then trans-
ferred to a CO_2 -incubator overnight. The virus
25 suspension used is the culture fluid of the marmo-
set cell line B95-8 as described (Miller, G. and
Lipman, M. Proc. Nat'l. Acad. Sc. U. S. A. 70:190,
1973). After overnight culture the B cells are
harvested from the petridish, counted and trans-
ferred to 96-well plates containing a confluent
30 layer of human fibroblasts (e. g. Flow 5000
cells). 40×10^4 cells are seeded in each well.
Cultures are fed twice weekly. The culture medium
is RPMI 1640 containing 10 % FBS, antibiotics and
35 2-ME.

1 This EBV-transformation scheme is depicted in
Figure 1.

6 d) Screening of culture supernates for antibody.

Supernates are harvested when the cultures have
grown to $1 \text{ to } 2 \times 10^5$ cells per well. The antibody
content is measured by hemagglutination using TNP-
SRBC, SRBC alone, and TNP-horse RBC. In parallel,
10 ELISA assays are set up with TNP-conjugated to
bovine serum albumin (G. J. Hammerlin, and J.
Kearney. Monoclonal antibodies and T cell hybridomas.
Perspectives and technical advances. Appendix,
Elsevier North Holland, 1981, p. 574). The
15 developing antibody is polyvalent, affinity purified
anti human IgG coupled with alkaline phosphatase.

Antibody-positive cultures so identified are
20 propagated further. Part of the cells are frozen
for future reference.

e) Cloning of EBV transformed cells. Precloning

25 Original cultures of EBV transformed cells contain
many isolated clusters of cells. As cells within
each cluster are relatively homogeneous individual
clusters are hand picked with the aid of a capil-
lary pipet and transferred to new 96-well plates
30 containing confluent monolayers of irradiated
human fibroblasts. Cells are allowed to grow to 1×10^5 /
well and supernates are again tested for
antibody by a suitable method, the method des-
cribed hereinabove at 1d, for example. Antibody-
35 positive cultures are again propagated by transfer
of individual clusters, or stored in liquid nitro-
gen for future use.

1 Cloning by growth in soft agar. This procedure is
 well known in the art, as for example disclosed by
 Sugden, B. and Mark, W. J. in Virol. 23:503
 (1977). Experimental results are given in Tables 1
 5 and 2.

Table 1

Exp.No.	No.of cultures	No.of antibody positive wells	No.of cell lines stable after 2 mos.	No.cell lines with 20 % rosette-for- ming cells
		TNP SRBC		
216	192	15 4	14	5
223	500	22 13	10	2
15 234	360	10 6	n. a.	n. a.

Table 2

Clone #	No.of cells seeded	No.of colonies growing	No.of. clones picked	No. of antibody positive clones	Ig class
223/38	10 ⁴	500	24	2	
25 223/97	10 ⁴	300	24	3	
223/187	10 ⁴	600	24	1	*
223/115	10 ⁴	800	24	0	
223/168	10 ⁴	500	24	0	-
223/287	10 ⁴	none	--	--	-

30 *recloning required

Legend to Tables 1 and 2:

35 100 ml of fresh heparinized blood was fractionated on
 ficoll-hypaque gradients, yielding 1.0 to 1.25×10^8 PBM.
 These cells were stimulated in culture with TNP-SRBC as

1 described under "technical notes". Five to seven days
later the B cells were isolated by passing the cells
over plastic dishes coated with affinity-purified poly-
valent rabbit anti-human IgG, using one 10 cm dish per 4
5 $\times 10^7$ cells. From 1.2 to 2.5×10^7 B cells were reco-
vered as the adherent fraction. They were 90 to 95 % Ig+
by immunofluorescence. B cells were infected with 3 ml
of undiluted culture fluid of the marmoset cell line
B958. Cells were then diluted with RPMI medium contain-
10 ing 10 % FBS to 2×10^5 cells/ml and seeded on 96-well
plates. These contained a confluent layer of human fibro-
blasts and were irradiated with 4000 rads before use.
Each well received 2×10^4 B cells. Growth was noticeab-
le after 2 weeks, and after 4 weeks cultures were tested
15 for antibody using three assays:
1) addition of TNP-SRBC to wells and reading hemaggluti-
nation patterns,
2) hemagglutination to anti-TNP-SRBC, TNP horse and SRBC
in Terasaki plates,
20 3) ELISA with TNP-BSA as antigen.
Twenty-three cultures showed antibody activity to SRBC
and 47 to TNP (see Table 2). Cells from positive cultures
were frozen in liquid nitrogen. Of the 35 cultures
carried further, 24 discontinued making antibody; some,
25 probably due to overgrowth by irrelevant cells, at a
declining rate. To estimate the number of TNP-specific
cells, antibody rosettes were allowed to form with TNP-
SRBC. Of 20 cultures so tested, seven produced 10 % or
more rosettes, five had from 1 to 10 %, and the rest
30 were either negative, showed occasional rosettes, or were
ambiguous (clumps due to dead cells).

Attempts to clone anti-TNP secreting cells in agarose
were in part successful. Ten-thousand cells of 6
35 selected anti-TNP cultures were grown in 0.35 % agarose,
on top of an irradiated fibroblast monolayer overlaid
with 0.5 % agarose, using RPMI medium. Colonies

1 developed in five of the six cultures within 3 weeks.
They were picked under the stereomicroscope, transferred
to irradiated fibroblast feeders and grown to 10^4 - 10^5
cells/well. When tested by ELISA, 3 of 5 anti-TNP cell
5 lines yielded positive clones with varying frequencies
(see Table 3). Culture fluids were assayed by the ELISA
procedure of J. Kearney (G. J. Hammerling, U. Hammer-
ling, and J. Kearney. Monoclonal antibodies and T cell
hybridomas. Perspectives and technical advances. Appen-
10 dix, Elsevier North Holland, 1981, p. 574). Immunochemi-
cal assays to show homogeneity and monoclonality of
human Ig are underway. Assays with class-specific and L
chain-specific mAb by ELISA showed clones 223/38 and
223/97 to be IgG, whereas clone 223/187 was ambiguous
15 and probably still represents a mixture. These results
reinforce our opinion that in vitro immunization of non-
immune lymphocytes, rescue of immune cells so generated
by EBV transformation, and cloning in soft agar is a
viable method for the production of human mAb.

20

Cloning by limiting dilution in microcytotoxicity plates
Microcytotoxicity plates (Falcon #3034) were seeded with
human fibroblasts and grown to confluency. They were
25 irradiated with 2000 rads. Two $\times 10^3$ normal human B
cells prepared by panning (see 1c) were added to each
well, followed by the EBV-transformed cells to be clo-
ned, at a rate of one to 5 cells per well. Plates were
cultured in a humidified atmosphere in a tissue culture
30 incubator. After 24 hr 10 microliters of medium were
added. No further feeding was required. When grown to
 10^3 cells/well EBV transformed cells were transferred to
96-well plates with human fibroblast feeder cells. Se-
lection for antibody was performed as described herein-
35 above, Section 1d.

1 Test for clonality:

Two criteria were used:

- 5 1) restriction to a single type of L chain and to single class of immunoglobulin. The analysis for light chain expression was done by ELISA assay. Class and L chain specific murine monoclonal antibodies to human Ig were used.
- 10 2) Recloning yielded antibody-forming cultured in about 98 % of culture wells.

Cloning in 96-well plates.

15 An alternate method employed 96-well plates with human irradiated fibroblast as feeder cells. Additional feeder cells were irradiated (1500 rad). Cells of the HPRT-negative variant GM 1500-6TG (Croce, C. M., Linnenbach, 20 A., Hall, W., Steplewski, Z. and Koprowski, H. Nature 288:488, 1980), added to the wells at 10^4 cells/well. One to five EBV-transformed cells to be cloned were added. Cultures were fed with medium twice a week. After 2 to 3 weeks the culture medium was mixed with 2 % 25 hypoxanthine, aminopterin and thymidine (HAT) to eliminate any growth of feeder cells. Selection for antibody positive cultures is carried out after 4 to 6 weeks, as described hereinabove in Section 1d.

30

II. Human mAb to lymphocyte surface antigens HLA: DRa) Immunization in culture

35 Human PBL were obtained from volunteer donors previously identified to have high titers of anti-HLA antibody as a result of pregnancy or

1 blood transfusion. PBL were isolated as described
hereinabove under 1a. PBL were suspended in Mis-
hell-Dutton medium. Irradiated (1500 rad) peri-
5 pheral blood lymphocytes from the immunized do-
nors (i. e. in case of a pregnancy PBL of the
husband or the child) served as antigen. Alterna-
tively an irradiated permanent B cell line de-
rived by EBV transformation from the immunizing
donor may be used. Antigen was added at a rate of
10 0.1 % of PBL to be immunized. The Mishell-Dutton
culture was performed as described hereinabove
under 1b.

15 b) Isolation of B cells and transformation

This was performed as described hereinabove under
1c.

20 c) Screening of supernates for antibody to cell
surface antigens:

The microcytotoxicity assay was applied. To 5
microliters of supernate were added 1 microliter
of a suspension of test cells (usually 2×10^6
25 cells/ml of transformed B cells of the immunizing
donor) and 2 microliters of selected rabbit com-
plement at 1 : 3 dilution. The assay plates were
incubated at 37° for 45 min., and scored on an
inverted microscope after addition of 5 microli-
30 ters of trypan blue solution.

d) Cloning of transformed cells.

This procedure may be performed as described by
35 one of the methods of 1e.

1 f) Assay for specificity.

Antibodies were tested by the microcytotoxicity
 5 assay on a wide panel of cells according to
 standard tissue typing protocols. An example is
 given in Table 3.

10 Table 3

Evaluation of Antibody Specificities -
 Tests with Frozen Panel Cells

	Supernatant Number	Immunizing Cell Type	Panel Test Results*	
			T-cells	B-CLL
15	1537-258/44 AP	A1,2;B8,27;DR1,3	18/25	2/23
	1540-253/26	"	11/25	3/23

	1511-258/59	A2,w31;Bw35,w50	21/25	17/23
	1515-258/53.10	"	0/25	7/23
20	1535-258/14.20	"	4/25	0/23
	1536-258/117	"	24/25	15/23
	1538-258/G43	"	13/25	1/23
	1539-256/12AP	"	0/25	0/23
	1541-258/G61	"	3/25	0/23
25	1542-258/18.9	"	0/25	0/23
	1554-266/82.4	"	11/25	9/23

*None of the reaction patterns showed correlations with
 30 known HLA-A, B, C or DR allospecificities.

Antibodies to several distinct alloantigens of
 human lymphocytes were obtained. The reactivity
 patterns were not congruent with any known HLA
 35 antigens.

1 III. Human monoclonal antibodies to Cytomegalovirus
 (CVM)

5 a) Immunization in culture

 This step is not required, as hyperimmune cells
 can be recovered from patients reconvalescent
 from cytomegaloinfection, or from chronic CMV-
 infected individuals.

10 b) Transformation

 Hence, the PBL obtained from 50 ml of blood were
 directly fractionated to yield B cells and these
15 were transformed with B95-8 EBV als described
 under Ib.

 c) Screening for antibody to CMV

20 The ELISA assay is used as described (G. J.
 Hammerling, U. Hammerling, and J. Kearney.
 Monoclonal antibodies and T cell hybridomas.
 Perspectives and technical advances. Appendix,
 Elsevier North Holland, 1981, p. 574). 96-well
25 plates were coated with antigen (CMV CF antigen
 Strain AD169 from Flow Laboratories or control
 antigen) cell lysate of HEF cells. After blocking
 with BSA, culture fluids are transferred to the
 plates, which are incubated for 2 hours at room
30 temperature. Plates were washed with Tween/PBS,
 and developing antibody, i. e. rabbit-antihuman
 IgG conjugated to alkaline phosphatase, was ad-
 ded. After 2 hours, the plates were washed again
 and nitrophenylphosphate substrate was added. The
35 result was recorded after 1 to 2 hours by an
 automatic Elisa-scanner.

1 d) Cloning by the limiting dilution technique

Clones of cell line 311/125 produce an antibody of IgG, Kappa type.

5

e) Fusion of EBV-transformed cells with human myeloma cells

10 2×10^6 EBV-transformed cells (not necessarily fully cloned) were mixed with 4×10^6 human myeloma cells (e. g. the HPRT-negative variant and ouabain-resistant variant of cell lines GM1500, 6TG (Croce, C. M., Linnenbach, A., Hall, W., Steplewski, Z. and Koprowski, H. Nature 15 288:488, 1980), WIL-2, ARH (American Type Culture Collection). Murine plasmacytoma cell lines X63.5.6.3 can also be used. The cell mixture was centrifuged and the cell pellet mixed with 1 ml PEG 4000 (35 % solution) for 1 min. at RT. The 20 mixture was then diluted dropwise with EBSS at a rate of 15 microliters in the course of 3 minutes. The cells were spun down, taken up in PRMI medium containing 2 % HAT and plated on irradiated human fibroblast feeder cells in 96-well 25 plates at a density of 10^5 cell per well. Cultures were fed on the second day with 5×10^{-8} M ouabain and HAT, and this feeding procedure was continued twice a week thereafter. After 2 weeks cells were harvested, layered on ficoll-hypaque 30 and centrifuged. Viable cells from the interface were plated again as before. When vigorous growth occur supernates were screened for antibody as described in 3c.

35 f) Characterization of (312a91) anti-CMV antibodies

Specificity analysis by ELISA technique with

1 standard CMB antigen AD169 (Flow Laboratories)
suggested the presence of anti-CMV antibody,
hereinafter designated 312a91.4. Immunofluores-
5 cence assays with human fibroblasts infected with
AD169 cytomegalo-virus, but not with uninfected
cells, corroborates the specificity for CMV, and
moreover suggests a relationship to nuclear CMV
antigen. The antibody 312a91.4 does not neutra-
lize CMV.

10
Immunochemical analysis shows that the hybridoma
312a91.4 secretes immunoglobulin G with kappa
chain. The anti-CMV antibody binds to Protein A.

1 What is Claimed:

1. Method for preparation of hybridomas which produce human monoclonal antibodies recognizing a desired antigen comprising:
 - a) immunizing human peripheral blood lymphocytes (PBL) with said antigen;
 - b) transforming the immunized lymphocytes with a viral agent to generate immortalized cells; and
 - 10 c) fusing the transformed cells with a second immortal cell line.
2. Method of Claim 1 comprising in addition the step of cloning transformed cells, screening the cloned transformed cells for antibody secretion and selecting the efficient antibody emitters for fusion.
3. Method of Claim 1 wherein said PBL are immunized in vitro.
4. Method of Claim 1 wherein said PBL are obtained from individuals exposed to said antigen.
5. Method of Claim 3 for preparing hybridomas which produce human monoclonal antibodies recognizing HLA, A, B, C antigen or DR antigen wherein human peripheral blood lymphocytes are immunized with said antigen in vitro.
6. Method of Claim 4 for preparing hybridomas which produce human monoclonal antibodies recognizing HLA-A, B, C or DR antigen wherein said PBL are obtained from the blood of multiparous women with high anti-HLA and/or DR antibody titer.
7. Method of Claim 1 wherein said viral agent is Epstein-Barr virus.

- 1 8. Method of Claim 1 wherein said immortal cell line is
of murine or human origin.
- 5 9. Method of Claim 8 wherein said immortal cell line is
mouse myeloma or a human plasmacytoma.
10. Method of Claim 1 wherein said PBL are cryopreserved
prior to immunization.
- 10 11. Hybridomas prepared by the method of Claim 1.
12. Human monoclonal antibodies produced by the hybridomas
of Claim 11.
- 15 13. Hybridomas prepared by the method of Claim 2.
14. Human monoclonal antibodies produced by the hybridomas
of Claim 13.
- 20 15. Method of Claim 1 for preparing hybridomas which
produce human monoclonal antibodies recognizing
cytomegalo virus antigens comprising transforming
peripheral blood lymphocytes from an individual
exposed to cytomegalo virus with a viral agent to
25 generate immortalized cells and fusing the transformed
cells with a second immortal cell line.
16. Hybridomas prepared by the method of Claim 15.
- 30 17. Human monoclonal antibodies produced by the hybridomas
of Claim 16.
18. Human monoclonal antibodies of Claim 17 produced by
cell lines deposited at the American Type Culture
35 Collection under the deposit numbers HB 8317 and CRL
8316.



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(71) Applicant: Sloan-Kettering Institute For Cancer Research
1275 York Avenue
New York New York 10021(US)

(72) Inventor: Hammerling, Ulrich
430 East 63 Street
New York New York 10021(US)

(72) Inventor: Hoffman, Michael K.
132 Greene Street
New York New York 10012(US)

(74) Representative: Patentanwälte Schulze Horn und
Hoffmeister
Goldstrasse 36
D-4400 Münster(DE)

(54) Process for producing human monoclonal antibodies.

(57) A method for producing human monoclonal antibodies from human B-lymphocytes comprising the steps:

1. immunization of human B-lymphocytes;
2. transformation of HBL by a viral agent to generate immortalized cells;
3. selection of cells secreting specific antibodies and cloning of these cells; and
4. fusion of the cloned cells with suitable human or mouse myeloma cells to generate high-secreting hybridoma, and cloning of these hybridomas is disclosed.

The method may be used to produce human monoclonal antibodies which recognize HLA, A, B, C or DR antigens and also to produce human monoclonal antibodies recognizing cytomegalo-virus antigens. Human monoclonal antibodies deposited at the American Type Culture Collection with deposit numbers HB 8317 and CRL 8316 have been produced by this method.

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EUROPEAN SEARCH REPORT

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Application number

EP 84 10 7961

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y, P	EP-A-0 090 898 (GENETICS SYSTEMS CORP.) * Page 2, lines 13-26; page 2, line 30 - page 3, line 14; page 4, lines 4-15, 24-33; page 5, line 1 - page 6, line 5; claims 1, 3, 8 *	1-18	C 12 N 15/00 C 12 N 5/00 C 12 P 21/00 G 01 N 33/577 A 61 K 39/42
Y	--- EP-A-0 072 752 (RESEARCH CORP.) * Page 2, line 28 - page 3, line 6; page 3, lines 23-29; page 4, line 8 - page 5, line 2; page 13, lines 3-26; claim 2 *	1-18	
A	--- EP-A-0 003 173 (THE MASSACHUSETTS GENERAL HOSPITAL) * Page 2, line 28 - page 4, line 26; page 7, line 21 - page 8, line 10; page 8, line 19 - page 9, line 4; claims 1-12 *	1-4, 7, 8, 11, 12	TECHNICAL FIELDS SEARCHED (Int. Cl.4) C 12 P A 61 K
A	--- EP-A-0 057 107 (COATS PATONS PLC) * Page 1, lines 1-19; page 3, line 19 - page 4, line 3; page 4, lines 10-14; page 5, lines 13-19, 23-30; claim 1 *	1-4, 8, 11, 12	

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 24-04-1987	Examiner CHARLES D.J.P.I.G.
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			